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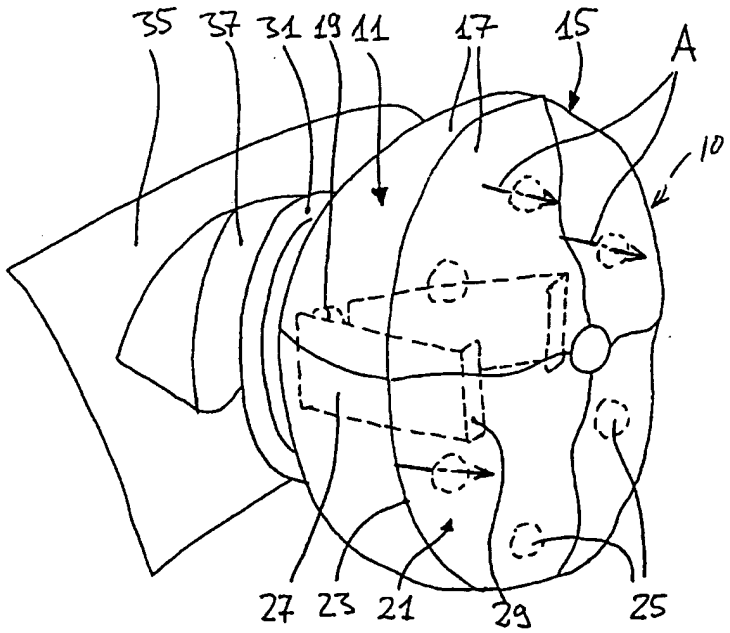
(54) Title: AIRBAG WITH CHAMBERS

(57) Abstract

The invention relates to an airbag (10) for impact protection of the occupants of a motor vehicle, which airbag (10) has an outer shell (15) that can be inflated with gas through a gas inlet opening (19). The airbag (10) has an internal flow–inhibiting separating wall (21) which is provided inside the outer shell (15) and separates the inner volume of the outer shell (15) into at least one first chamber (11) and one second chamber (13), in such a way that the first chamber (11) is first inflatable through the gas inlet opening (19) to form a base volume, and the second chamber (13) is inflatable intentionally delayed in time by the inner separating wall (21) for the subsequent inhibited enlargement of the airbag volume in the direction of an impact zone.



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AIRBAG WITH CHAMBERS

The invention relates to an airbag for impact protection of the occupants of a motor vehicle, the airbag having an outer shell that can be inflated with gas through a gas inlet opening.

After detection of an abrupt decelerating movement of the motor vehicle the conventional airbag is opened rapidly by inflation in the direction of a collision zone in which the vehicle occupant interacts with the airbags. One of the objectives of the invention is to devise an airbag which assures a rapid and simultaneously gentle impact protection for a motor vehicle occupant.

This objective is accomplished for the airbag of the type mentioned above by a flow-inhibiting internal separating wall provided inside the outer shell which separates the interior space of the outer shell into at least one first chamber and one second chamber in such a way that initially the first chamber may be inflated into a base volume through the gas inlet opening, while the second chamber may be inflated with an intentional time delay caused by the inner separating wall thus cushioning the further enlargement of the airbag volume in the direction of an impact zone.

The inner separating wall according to the invention therefore divides the interior volume of the airbag into at least two chambers. Through the gas inlet opening provided on the first chamber, the first chamber may initially be inflated essentially fully and tightly, while because of the flow-inhibiting action of the inner separating wall the second chamber only becomes fully inflated later relative to the total inflation of the first chamber. The inflation of the airbag therefore takes place in two steps, during which the internal separating wall

selectively lowers the speed of the influx of gas from the first chamber into the second chamber relative to the velocity of the gas flowing through the gas inlet opening into the first chamber. A time-delayed inflation of the second chamber in accordance with the present invention therefore is present even if the second chamber is inflated simultaneously with the inflation of the first chamber but at reduced speed.

The airbag according to the invention has the advantage that part of its volume can be inflated in an inhibited way and thus more gently relative to an occupant, while a certain base volume of the airbag has already been inflated so that impact protection of the occupant is basically provided by known means. The outer shell of the airbag after reaching this base volume moves toward the anticipated impact zone at reduced speed so that an impacting occupant is under certain conditions pushed backward until the airbag reaches the intended total volume.

This operating mode with time-delayed inflation of the two chambers can be achieved especially advantageously if a two-step gas generator is used for inflating the airbag according to the invention, i.e., a gas generator which, in a first step, releases a certain volume of gas at a certain pressure and, in a subsequent second step, releases an additional quantity of gas especially at a higher pressure. Alternatively to the use of a two-step gas generator, a time-delayed inflation of the two chambers can also be achieved on the basis of the flow-inhibiting action of the inner separating wall even when a single-step gas generator is used without an additional ignition mechanism. No nominal breaking points or tear lines are necessary inside the airbag in either case.

Another advantage of the airbag according to the invention is the fact that the first chamber may be inflated very rapidly because of its small base volume relative to

the total volume of the airbag and may accordingly be brought into the desired position inside the motor vehicle.

For fixation on the inside of the airbag's outer shell, the inner separating wall according to the invention can be stitched or welded to the outer shell.

The inner separating wall of the airbag according to the invention relative to that cross section of the inner volume of the inflated airbag which corresponds in its position to the intended reach of the inner separating wall is preferably designed as a predominantly or totally closed area. In the first case, the inner separating wall may be partly gas permeable; in the second case, it must be partly gas permeable. Such a gas permeability of the inner separating wall can be achieved especially as follows:

For example, the inner separating wall may consist of a material which is permeable for the gas intended for inflating the airbag. Alternatively or additionally the inner separating wall may have openings, especially slit openings or perforations through which gas can flow from the first chamber into the second chamber. These openings may be distributed along the inner separating wall and especially inside its border strip. It is also possible for the openings to be designed in such a way that the inner separating wall is not affixed along its entire border strip to the inner side of the airbag outer shell. In this case the openings are formed along those segments of the border strip which are not connected to the airbag outer shell but rather face it without attachment, for example.

In order to achieve the inflation of the two chambers of the airbag in two distinctly pronounced successive steps the inner separating wall may be designed to be pressure dependent in its flow-inhibiting action so that it permits the gas to

flow through as a function of the pressure difference prevailing between the gas of the first chamber and the gas of the second chamber.

This pressure-dependent behavior of the inner separating wall may be relatively abrupt so that gas may flow from the first chamber into the second chamber only after a certain minimum pressure difference is reached. Such an airbag design may be combined especially advantageously with the above-mentioned use of a two-step gas generator, in which case the pressure difference, and therefore the flow behavior of the inner separating wall and the beginning of inflation of the second chamber can be governed very precisely in time. Alternatively to this, the pressure-dependent behavior may follow a continuous curve, i.e. with increasing pressure buildup inside the first chamber, gas may flow against an increasingly weaker inhibiting effect through the inner separating wall into the second chamber.

A pressure-dependent flow inhibition can be achieved, e.g., through openings inside the inner separating wall which display an increasingly larger opening area with increasing pressure and/or deformation of the inner separating wall, i.e., in a discontinuous or an essentially linear dependence on the pressure buildup.

In a preferred variant of the invention, the inner separating wall in the inflated state of the airbag extends transversely, especially essentially at right angles, to a main flow direction, in which the gas used to inflate the airbag flows through the gas inlet opening into the first chamber of the airbag. Alternatively or additionally it is preferable for the inner separating wall to be arranged transversely, especially essentially at right angles to a main impact direction in which the impact of a occupant of the motor vehicle is anticipated so as to be cushioned by the airbag. In this way the first chamber, the second chamber and

the impact zone may be arranged relative to the occupant in an extension of the main impact direction. The gas intended to inflate the second chamber may flow through the inner separating wall against the main impact direction in the case of an already inflated first chamber, and accordingly the second chamber may be inflated completely against the main impact direction.

In another preferred variant, the airbag according to the invention has at least one tension element inside its outer shell, especially a tension band which has a small area compared to the cross section of the inner volume of the airbag along the plane covered by the tension element. Such tension elements are commonly used for limiting the shape or volume of airbags. The known tension elements or tension bands are also unsuitable for fulfilling the function of the inner separating wall according to the invention, i.e., the inhibition of gas flow, because of their relatively small area. With the tension element according to the invention the inner separating wall is affixed to the inside of the outer shell in such a way that the position of the inner separating wall is stabilized during the inflation of the airbag as well as in the inflated airbag.

The invention assures high flexibility with regard to the volume ratios of the two chambers. For example, the volume of the first chamber of the inflated airbag may be larger than the volume of the second chamber in order to make a relatively large base volume available for a rapid and safe impact protection by the especially rapidly inflatable first chamber. Depending on the case of application, the volumes of the first and second chambers, however, may also be approximately equal, or the volume of the second chamber may be larger than the volume of the first chamber when the airbag is in the inflated state.

Other preferred variants of the invention are described in the subclaims. The invention is described in the following by examples of embodiment with reference to the drawings, in which:

Figures 1a and 1b: show a perspective view and a side view of a driver-side airbag according to the invention, where only the first chamber is completely inflated,

Figures 2a and 2b show a perspective view and a side view of the driver-side airbag in Figures 1a and 1b, where the first chamber and the second chamber are fully inflated,

Figures 3a and 3b show a perspective view and a side view of a top-mounted passenger airbag according to the invention in the fully inflated state,

Figures 4a and 4b show a perspective view and a side view of a centrally mounted passenger airbag according to the invention in the fully inflated state, and

Figures 5a and 5b show a perspective view and a side view of a bottom-mounted passenger airbag according to the invention in the fully inflated state.

Figures 1a and 1b show in a perspective view and a side view a first version of the airbag 10 according to the invention. The airbag 10 is mounted inside a motor vehicle and is provided there for cushioning the driver of the motor vehicle in the event of a frontal collision. This airbag 10 has a first chamber 11 which in the representation in Figures 1a and 1b is essentially fully inflated, and a second

chamber 13 which is only slightly inflated in the state of the airbag 10 shown. The two chambers 11, 13 are bounded by a common outer shell 15 which consists of several sections of fabric 17 stitched together. The first chamber 11 essentially has the shape of a spherical cap bounded by a circular cross section, with the second chamber 13 adjoining the circular cross section, and the outer shell 15 of the first chamber 11 on its side lying opposite the circular cross section has a gas inlet opening 19.

The two chambers 11, 13 are separated from each other by an inner separating wall 21 which essentially corresponds in its position and in its outline to the above-mentioned circular cross section of the first chamber 11. The inner separating wall 21 is stitched along a therefore essentially circularly running circumferential seam 23 to the fabric segments 17 of the outer shell 15 of the first chamber 11 or the second chamber 13.

The inner separating wall 21 has six uniformly spaced opening holes 25.

The first chamber 11 has in its interior two tension bands 27 which in each case are stitched to one end of the gas inlet opening 19 adjacent to the outer shell 15 of the first chamber 11 and at the other end to the inner separating wall 21 by means of a stitching segment 29.

The airbag 10 shown is affixed by the fabric segments 17 forming the outer shell 15 of the first chamber 11 in the vicinity of the gas inlet opening 19 to a steering wheel 31. This steering wheel 31 is connected via a steering column or its covering 33 to a front console 35 on which an instrument panel 37 is mounted in the region of the steering wheel 31.

Figures 2a and 2b show the airbag 10 according to Figures 1a and 1b in the corresponding views, respectively, with the same reference numbers always denoting the same parts. In the state of the airbag 10 shown in Figures 2a and 2b, both the first chamber 11 and the second chamber 13 are fully inflated.

The airbag shown in Figures 1a, 1b, 2a, and 2b preferably lessens the rearward motion of the driver of a the motor vehicle, e.g., caused by a frontal collision along a main impact direction C. A corresponding decelerating motion of the motor vehicle is registered via a suitable conventional sensor after which a gas generator (not shown) arranged, e.g., on the steering wheel 31 or the steering column cover 33, releases the quantity of gas necessary to inflate the airbag 10 within a short time.

This gas flows initially through the gas inlet opening 19 along a main flow direction B into the first chamber 11 so that the this chamber is rapidly essentially fully inflated. At the same time only a relatively small quantity of this gas flows in flow-through direction A from the first chamber 11 through the perforations 25 of the inner separating wall 21 into the second chamber 13. Since the inner separating wall 21 is formed as a closed area with only a small number of perforation openings 25 it retards the inflation of the second chamber 13 compared to the speed of inflation of the first chamber 11.

The state achieved immediately after the complete inflation of the first chamber 11 is shown in Figures 1a and 1b. The tension bands 27 at this time of inflation of the airbag 10 are already tight and cause the inner separating wall between the circumferential seam 23 and the stitching segments 29 of the tension bands 27 to tighten up so that the first chamber 11 retains the desired form of a spherical cap in the profile shown in Figure 1b. The inner separating wall 21 in this case

assumes the shape of a concavely curved membrane relative to the gas inlet opening 19 as indicated in Figure 1b by the cross-sectional outer contour of the inner separating wall 21, shown as a broken line. The inner separating wall 21 is essentially perpendicular not only to the main flow direction B but also to the main impact direction C.

After the inflation of the first chamber 11 the gas subsequently released by the gas generator finally also fully inflates the second chamber 13 as indicated in Figures 2a and 2b. At this time the inner separating wall 21 retains the above-mentioned membrane shape.

Other examples of embodiment of the airbag according to the invention, in each case in a version of a passenger-side airbag, are described below with reference to Figures 3a, 3b and 4a, 4b, and 5a, 5b, where the same reference numbers refer to the same parts as in Figures 1a, 1b, 2a, and 2b.

Figures 3a and 3b show an airbag 10 according to the invention in a perspective view and side view which is in the top mount design for the protection of a passenger of a motor vehicle. Figures 3a and 3b show this airbag 10 in the fully inflated state.

The chamber 11 which is inflated first and at relatively high speed extends along the top side of the front console 35 of the motor vehicle in the vicinity of the gas inlet opening 19. The inner separating wall 21 extends essentially in the vertical direction and perpendicular to the main impact direction C. Therefore the first chamber 11 bounded by the inner separating wall 21 to the extent that it is essentially fully inflated and the second chamber 13 not yet inflated, forms a vertical wall to protect the upper body of the passenger when he is flung in the

main impact direction C. As soon as the second chamber 13 is inflated through the gas inlet opening 19 and the inner separating wall 21 it can push the passenger back against the main impact direction C or hold the passenger in a cushioned and therefore gentle way. The totally inflated chamber 13 serves especially to protect the lower body of the passenger and prevents it from being flung vertically.

Figures 4a and 4b show a passenger airbag 10 according to the invention in the mid-mounted arrangement. In the fully inflated state of the airbag 10 shown here the inner separating wall 21 extends in the vertical direction and perpendicular to both the main flow direction B and also to the main impact direction C. The inner separating wall 21 is affixed along its entire essentially rectangular outline to the inner side of the outer shell 15 and thus separates its internal volume into a first chamber 11 and a second chamber 13 whose volume is only a fraction of the volume of the first chamber 11. In its center the inner separating wall 21 displays seven uniformly spaced perforation openings 25.

Figures 5a and 5b show another example of a passenger airbag 10 according to the invention affixed to the bottom of the front console 35 in the low-mounted arrangement. In this airbag 10 version the inner separating wall 21 does not run perpendicular to the main flow direction B but rather is slanted relative to a horizontal alignment. The base volume formed by the first chamber 11 below the inner separating wall 21 of this airbag therefore serves chiefly to protect and restrain the lower body of the passenger. Only the second chamber 13 which inflates with a time delay relative to the first chamber 11 above the inner separating wall 21 causes an effective and simultaneously relatively gentle protection.

As an alternative to the position of the inner separating wall 21 shown by the broken line in Figures 5a and 5b, this wall may also occupy an essentially vertical alignment as indicated by the broken-dotted line in Figure 5b. In this case the partial volume of the airbag 10 facing toward the passenger, therefore against the main impact direction C, would be inflated as the second chamber 13 with a time lag and at reduced speed.

CLAIMS

What is claimed is:

1. An airbag for impact protection of occupants of a motor vehicle, which airbag has an outer shell (15) that can be inflated with gas through an inlet opening (19), characterized by a flow-inhibiting inner separating wall (21) provided inside the outer shell (15) and separating the inner volume of the outer shell (15) into a first chamber (11) and a second chamber (13) in such a way that the first chamber (11) is inflatable first through the gas inlet opening (19) to form a base volume and the second chamber (13) is selectively delayed in inflation by the inner separating wall (21) for inhibited further enlargement of the airbag volume in the direction of an impact zone.

2. The airbag as in Claim 1, further characterized by the inner separating wall (21) relative to a cross section of the inflated airbag running along the plane expected to be covered by the inner separating wall (21) is designed as a predominantly or totally closed area.

3. The airbag as in Claim 1, characterized by the inner wall (21) being designed to be at least partly gas permeable.

4. The airbag as in Claim 1 characterized by the inner separating wall (21) being formed of essentially gas permeable material for selective admission of gas from the first chamber (11) into the second chamber (13).

5. The airbag as in Claim 1, characterized by the inner separating wall (21) being made of essentially gas-tight material.

6. The airbag as in Claim 1, characterized by the inner separating wall (21) displaying at least one opening, especially a hole opening (25) for selective admission of gas from the first chamber (11) into the second chamber (13).

7. The airbag as in Claim 6, characterized by the opening (25) being formed inside the inner separating wall (21) between a marginal strip (33) of the inner separating wall and the inside of the airbag outer shell (15) .

8. The airbag as in Claim 1, characterized by the inner separating wall (21) being designed to be flow inhibiting as a function of pressure, especially with openings which change their opening area as a function of the gas pressure acting on the inner separating wall (21).

9. The airbag as in Claim 8, characterized by the inner separating wall (21) permitting gas to flow from the first chamber (11) into the second chamber (13) essentially only after a certain minimal pressure difference between the first chamber (11) and the second chamber (13) is reached.

10. The airbag as in Claim 1, characterized by the inner separating wall (21) in the inflated state of the airbag (10) being mounted transversely to the main flow direction (B) in which gas flows through the gas inlet opening (19) into the first chamber (11) upon inflation of the airbag.

11. The airbag as in Claim 1 characterized by the inner separating wall (21) in the inflated state of the airbag (10) being installed transversely to the main direction (C) of impact.

12. The airbag as in Claim 1, characterized by at least one tension element, especially a tension band (27), being provided by which the inner separating wall (21) is connected to one of the outer shell (15) or to the motor vehicle and is preferably provided inside the first chamber (11).

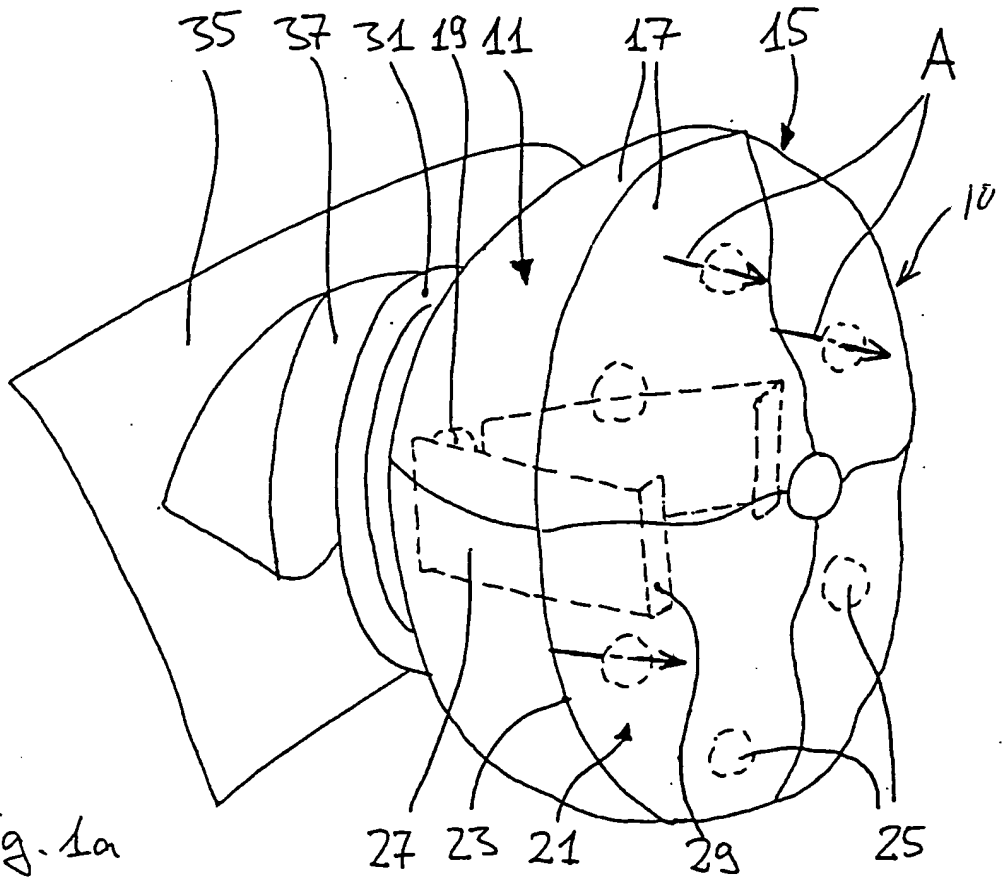
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Fig. 1a

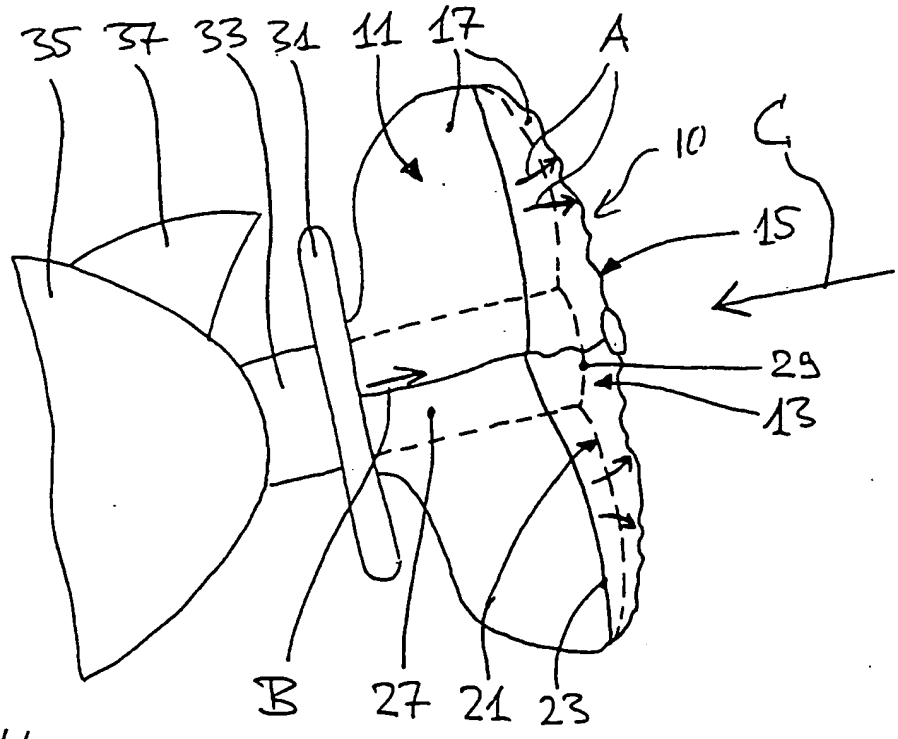
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Fig. 1b

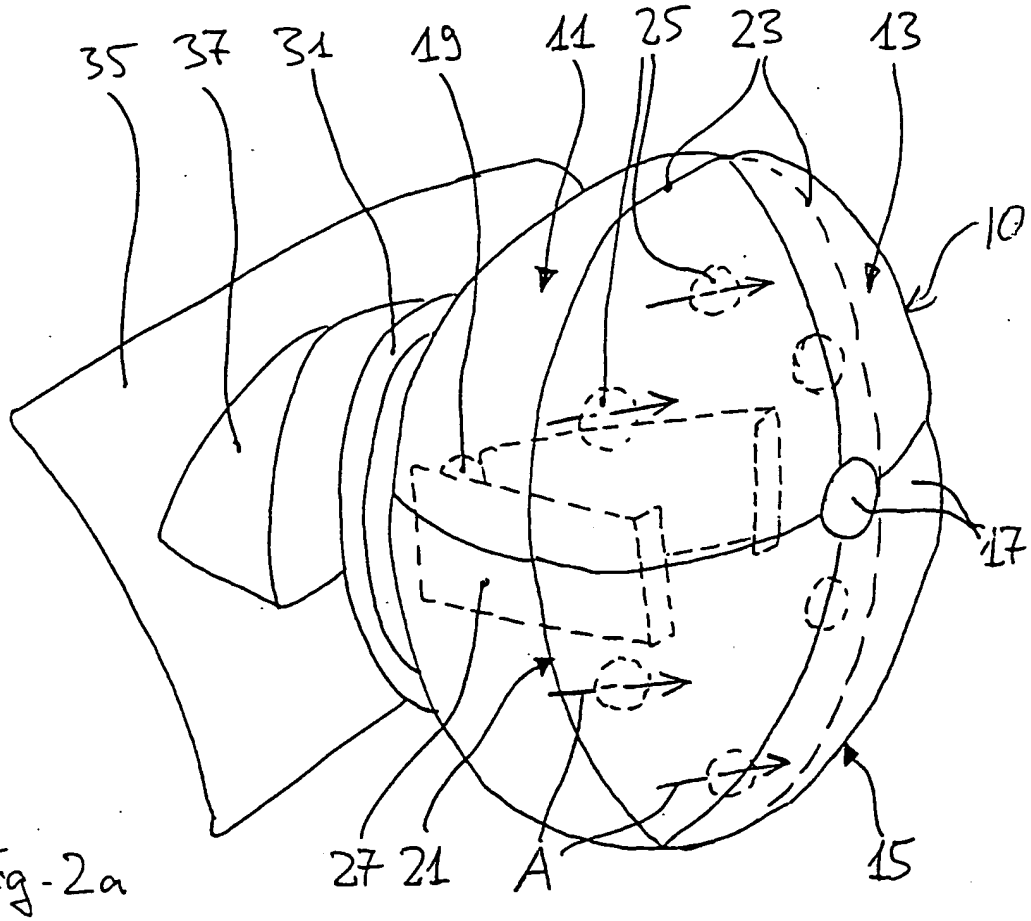

Fig-2a

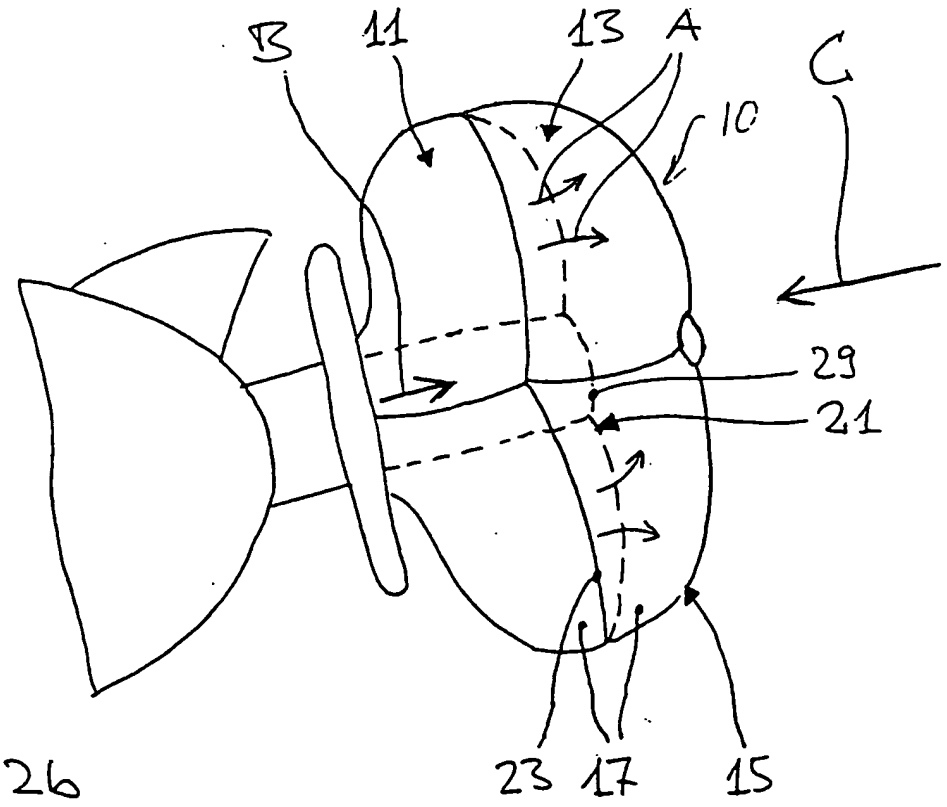

Fig-2b

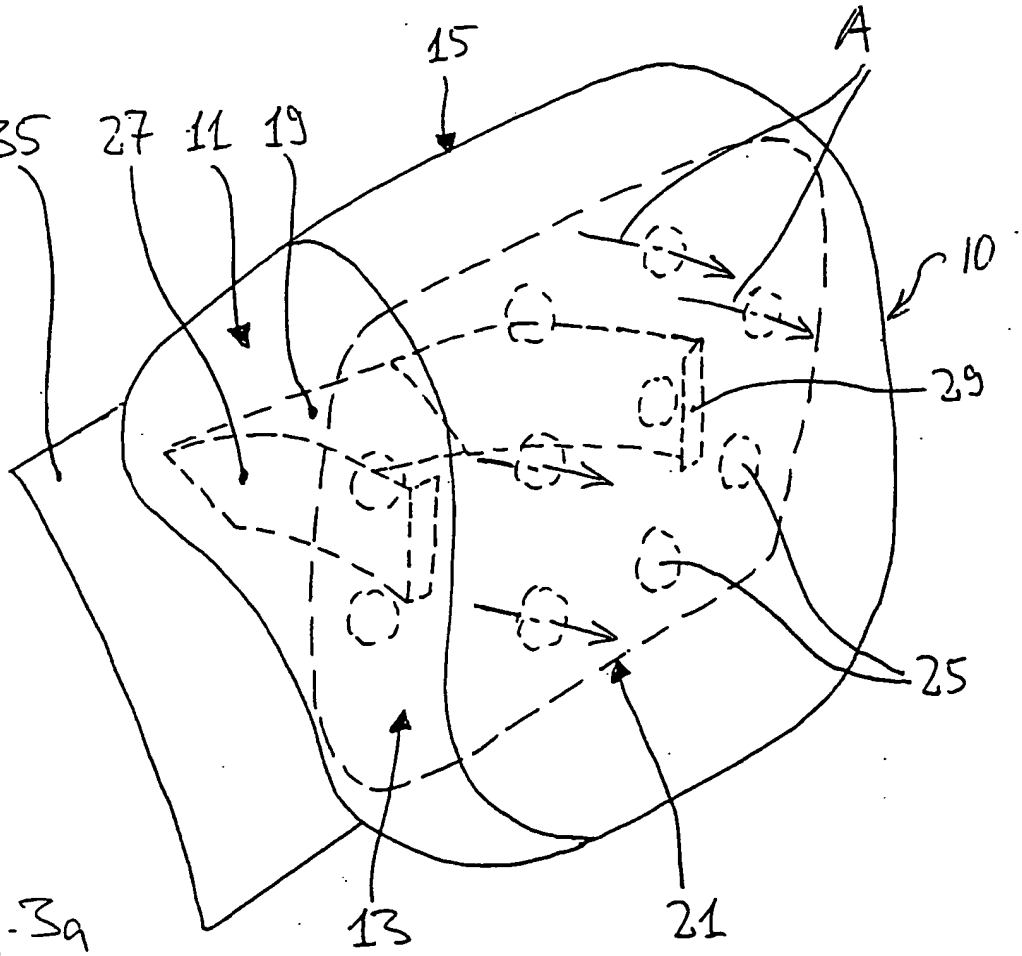

Fig. 3a

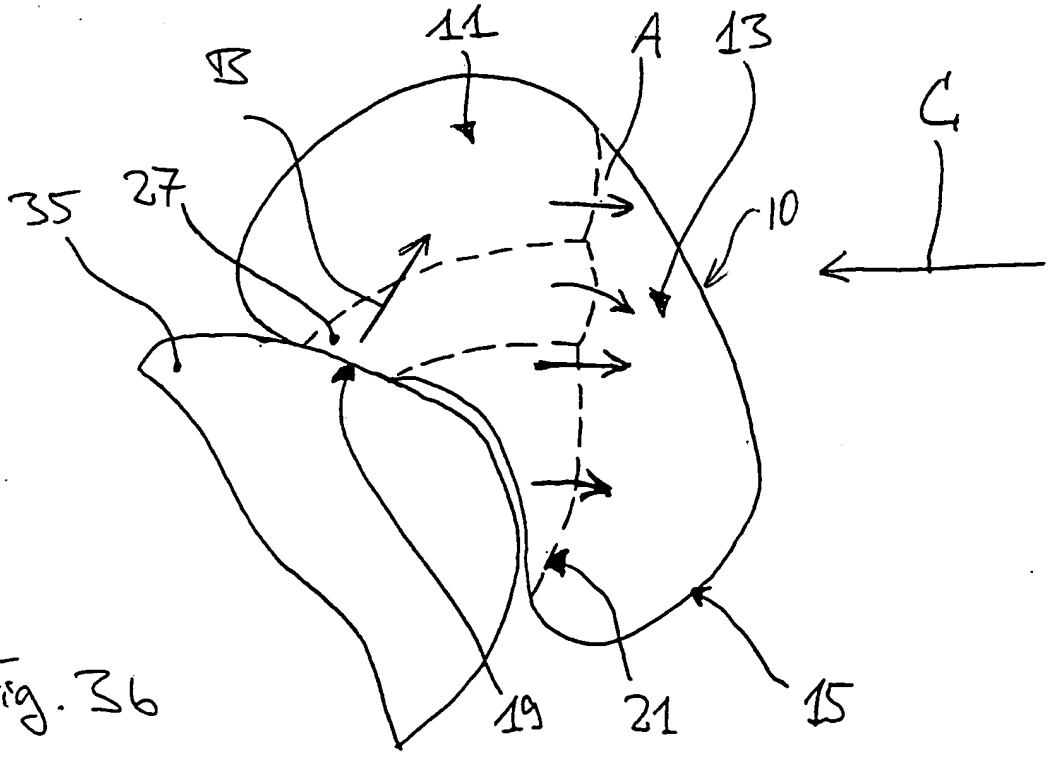

Fig. 3b

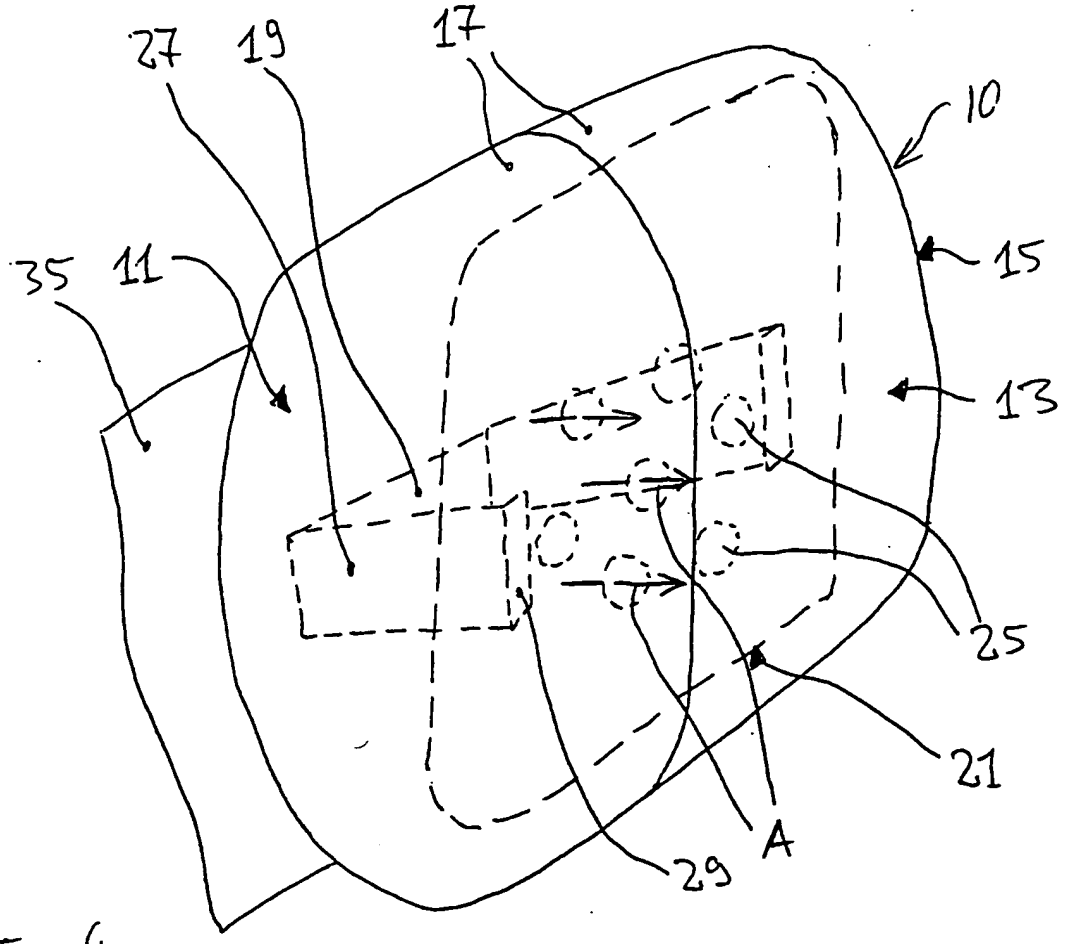

Fig. 4a

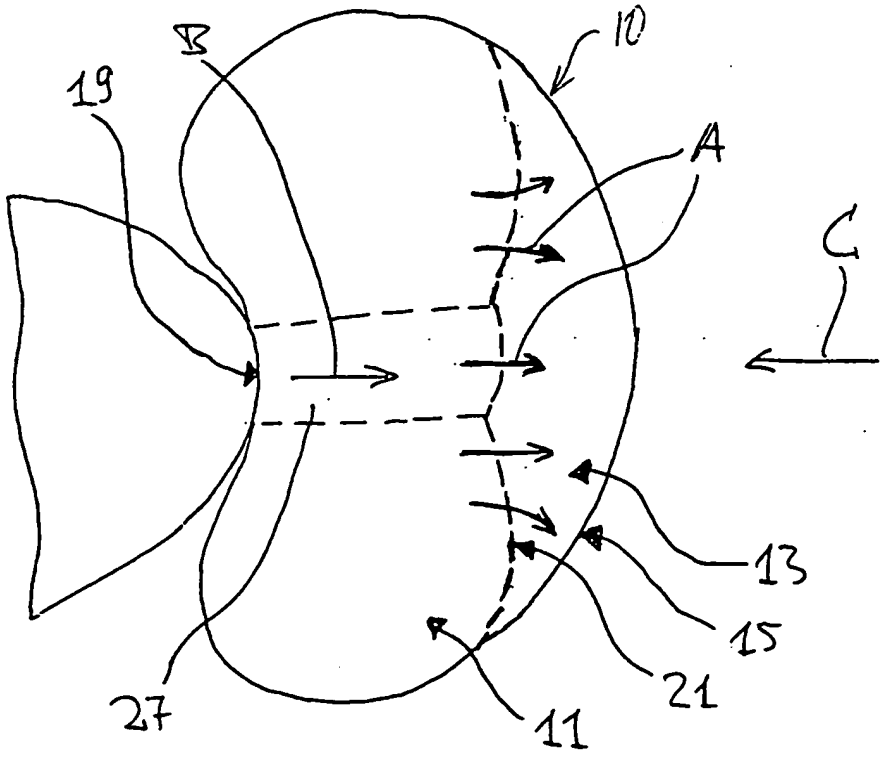

Fig. 4b

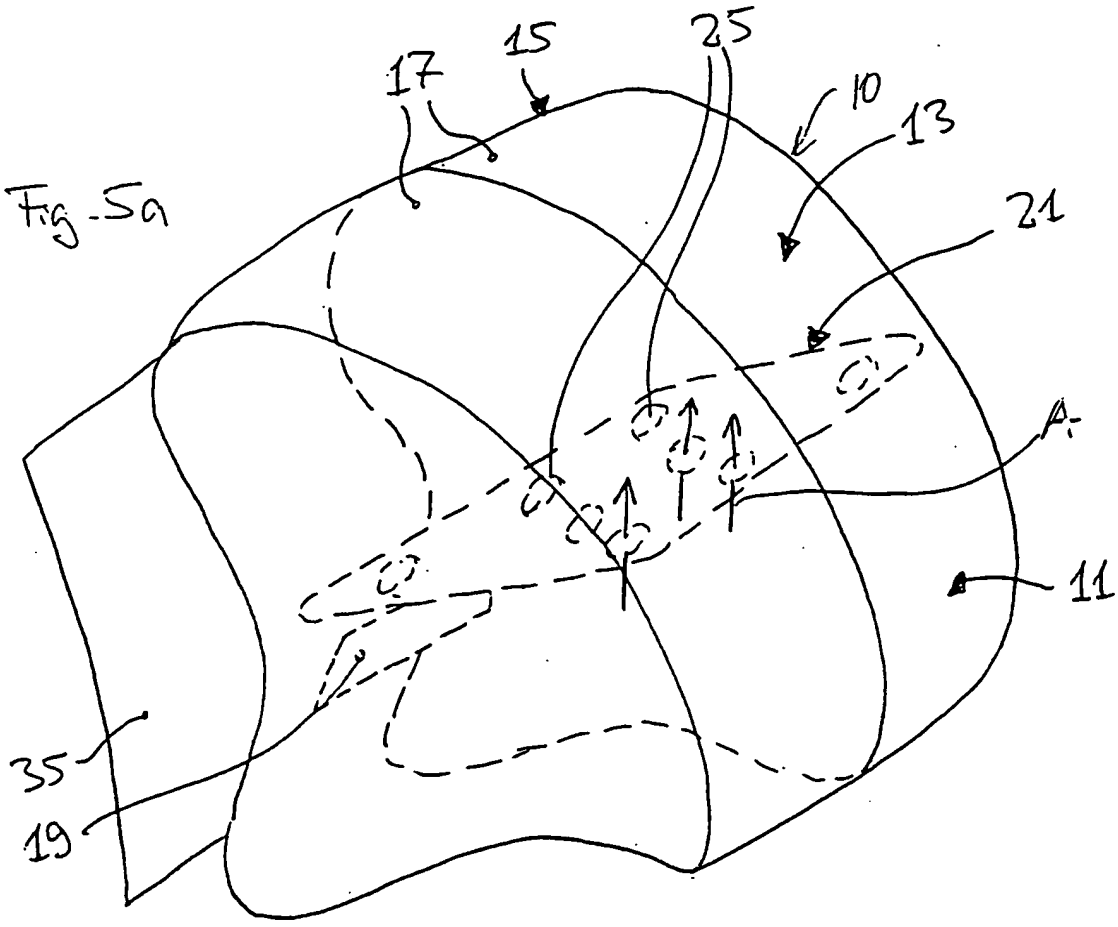

Fig.-5a

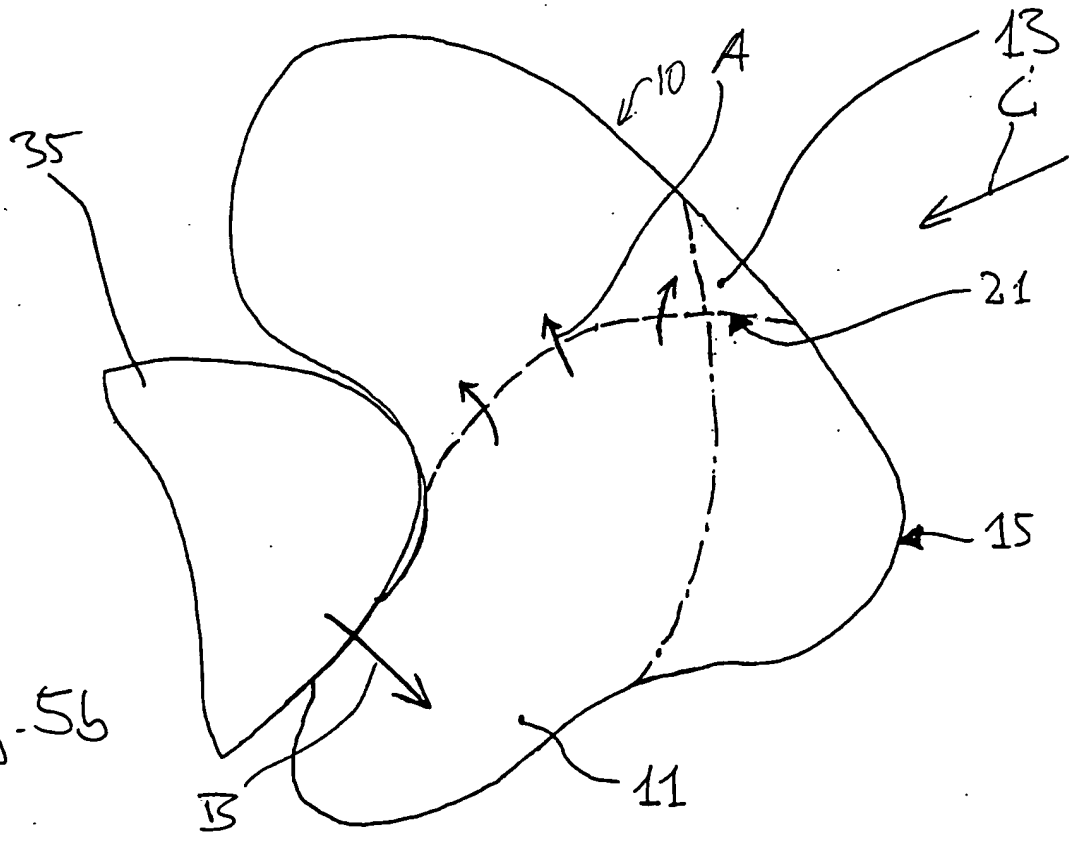

Fig.-5b

INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/US 99/19850

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R21/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 061 828 A (THIOKOL CORP) 6 October 1982 (1982-10-06) page 2, line 4 -page 3, line 1 page 4, line 9 -page 5, line 19 page 6, line 14 -page 7, line 11; figures 1,3	1,3,5,6, 8,9
Y	---	4
Y	US 3 900 210 A (LOHR THOMAS E ET AL) 19 August 1975 (1975-08-19) column 1, line 6 - line 17 column 1, line 41 - line 60 column 2, line 42 -column 3, line 13; figures 1,2	4
A	---	2,3,10, 11
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
23 December 1999	11/01/2000

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/19850

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 47497 A (HANAWA AKIFUMI ;KAKIYA MASAHARU (JP); OTANI YASUHIKO (JP); SENSOR) 18 December 1997 (1997-12-18) abstract; figures 1-6	1,2,6-11
X	EP 0 584 782 A (TRW REPA GMBH) 2 March 1994 (1994-03-02) column 1, line 1 - line 16 column 3, line 4 - line 58; figures 1-4	1,2,5,6, 10-12
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